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13. ABSTRACT (Maximum 200 words)

The primary goal in most scientific studies is to design an experiment which yields the maximum possible information about the phenomenon under study within the budgetary restraints. Our research addresses precisely this fundamental issue. Our recent discoveries not only add to the store of knowledge about the multiple facets of data collection and analysis, but have immediate applications to several fields of scientific investigation. In the U.S. Air Force they can be applied to communication engineering, equipment testing and aerospace medicine.

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MAJOR RESEARCH PROBLEMS UNDER AFOSR GRANTS

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Principal Investigators

May, 199?

A. Design of Experiments:

1- Optimal and Efficient Repeated Measurements Designs:

Any experiment in which one or more units are observed in two or more occasions(periods) falls in this category. The foundation of optimal design in this area is due to us. Hardly one can find an article in this area without our papers being referred. See for example, the survey article "Recent developments in crossover designs, International Statistical Review, Vol. 56(1988), pp.117-127 by J.N.S. Mathews.

New application: In our report we have indicated many applications of repeated measurements designs. We have discovered that such designs can be used to study seasickness and spacesickness which should be of interest to DOD. In our new proposal we intend to explore further the utility of such designs in these motion related sicknesses.

2- Optimal and Efficient Designs for Comparing Test treatments with Controls:

Once again the basic and the fundamental theory of the subject belong to us.See what the expert discussants of our invited paper"Optimal designs for comparing test treatments with controls, Statistical Science, Vol.3 (1988), pp.462-491 say about our contributions. Robert Bechhofer and Ajit Tamhane ,on page 477, say " Hedayat, Jacroux and Majumdar, who have been at the forefront of this research, are to be congratulated...." William Notz, on page 480, says " This paper is an excellent starting point for anyone wishing to do research in this area and it is a nice reference for those of us actively engaged in such research.." John D. Spurrier, on page 485 says " Professors Hedayat,Jacroux and Majumdar are to be congratulated for the excellent job they have done of summarizing the vast amount of research that has been done over the last several years in the problem of comparing several treatments with a control or a standard treatment.....I hope that one major contribution of their article is to make applied researchers aware of the need for special designs in the treatment versus control problem....."R.J. Owen, on page 486, says " I would like to commend the authors for this broad and valuable review of the literature on optimal designs for comparing treatments with control..."

3. Trade-off Theory in Design:

We are proud to say that this theory, which is a blend of combinatorial topology (such as triangulation of compact bodies) and practical design of experiments in the field, is due to us. For this reason one of us (Hedayat) was invited to spend over two months (April-June, 1988) at The Institute of Mathematics and Its Applications ,University of Minnesota, to explain and interact with expert visitors in two workshops organized by the institute. An Invited article will soon appear in the IMA volume in this regard. This theory is useful for changing the site of experimentation without losing the statistical properties of the design.

4- Factorial Experimentation:

The first book on Factorial Design was appeared in print in 1981 under Wiley publication. The book was coauthored by Walter Federer (Cornell University), A.S.Hedayat(University of Illinois, Chicago), and B.L. Raktoe (University of Guelph, Ontario). We have obtained many results in this area and have indicated their applications. It is fair to say that we have been an invited speaker in almost all national and international conferences in this area.

B. Reliability Models:

1- Multistate Coherent Systems:

The theory of multistate coherent systems, whose foundation was laid in 1978 by us(El-Neweihi) in the journal of Applied probability, is still in its developmental stage. Inspired by our paper and recognizing the significance of such theory a host of researchers all over the world have taken a keen interest in the subject and have produced a large number of papers in such a short span of time. Those researchers are in a wide variety of disciplines such as reliability, management, engineering, etc. We have continued to contribute vigorously to the area.

Whereas the classical reliability theory insists on the assumption that systems and their components can only be in one of the two states functioning or failed, the new multistate theory allows both systems and components to perform at various levels ranging from perfect functioning to total failure. This fundamental departure from binary variables to multivalued variables greatly increases the mathematical complexity of the subject, but the rewards are handsome. When this theory reaches maturity it will have two major impacts (i) it will lead to a more accurate modeling of situations that are already within the scope of binary reliability analysis (ii) it will extend the realm of reliability analysis to situations that could not have been handled by existing binary models which suffer from the limitation that objects of study must be represented by binary variables.

Recently we discovered that flow networks provide some beautiful examples of multistate systems including ones with Schur concave structure functions. We are confident that our combined knowledge of multistate theory and flow networks will inspire interesting results in multistate theory which are directly inspired by practical flow networks.

2- Optimization Models:

We have discovered many exciting results in the areas of (i) optimal allocation of components, (ii) a standard method of strengthening a component, and (iii) optimal order of inspection and repair. The details have appeared in our reports and publications.